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XXV.

FEATURES OF CRYSTALLINE GROWTH.

BY OLIVER WHIPPLE HUNTINGTON.

Presented June 12, 1889.

VARIATIONS IN THE BUTCHER IRONS.

In a former paper [*] the author discussed in some detail the crystalline structure of iron meteorites, and in a second [†] described the cleavage exhibited by various specimens of the Coahuila group of irons, which are generally supposed to have come from the same original mass. It was then shown that in this group of irons the Butcher specimens differed so markedly from those of Saltillo (Santa Rosa) that the cleavage seemed to offer a conclusive means for separating the two falls, though the appearance of the etched surfaces failed to distinguish them.

As several very large individual masses of these irons are now in the Harvard Cabinet, under the general name of "The Butcher Irons," we were interested to see whether any peculiarity of structure would further distinguish them as independent meteorites, or whether on the contrary they could be identified as having unquestionably come from the same original body. A careful examination of the exterior of these irons showed that they had begun to break up since becoming the property of Harvard College, but this alteration had only taken place in certain parts of the specimens. The largest specimen seemed to have a zone running through the thickest part from which could be detached with little difficulty octahedral fragments of iron made up of distinct plates, showing a cleavage very similar to the well known Putnam County iron, while the rest of the mass was compact and unaltered. Thus certain parts of the Butcher specimens appeared to have an entirely different structure from what we are accustomed to associate with these irons. They have heretofore been known as typical "cubic irons," and, though it has been shown that all the twin members of the regular octahedron cube and dodecahedron appear on the surface of fracture, still the cube gives character to the iron, and, together with the etched surface, serves to connect it closely with the Braunau (Hauptmannsdorf) and other so called cubic irons.

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[*] Proceedings of the American Academy, vol. xxi. p. 478, May, 1886.

[†] Ibid., vol. xxiv. p. 30, October, 1888.

In seeking to explain this apparent variation in the structure of the Butcher specimens, a number of large masses were polished and etched. The most striking result was obtained on a specimen which formed one end of a large mass originally cut up by Ward and Howell for the late J. Lawrence Smith. This surface as it appeared after etching is shown, one third the natural size, in Plate I., which was made directly from a photographic negative. The figure, although so much reduced, shows clearly a zone passing through the thickest part of the mass characterized by a very different crystallization from the rest of the piece. The greater portion of the etched surface is covered only with Neumann lines so characteristic of the Coahuila irons. These lines, although not well shown in the photograph, are plainly exhibited by the print from an etched plate previously published.* This last feature is characteristic of the outside of the mass, where the cooling must have been quicker and the crystallization more rapid and disturbed, though following, nevertheless, the fundamental forms of the regular system. In the central zone, however, corresponding to the thickest part of the specimen, the iron appears to have crystallized more slowly, and exhibits all the characters of Widmanstättian figures resulting from well marked crystal plates; and here the octahedron appears to predominate, though the presence or absence of the cube and dodecahedron cannot be established by the examination of only a single etched surface cut at random.

The etched surface of another portion of the same mass seemed to explain this contrast of coarse and fine grained crystallization. There is in the Harvard collection the largest slab ever cut from the Coahuila specimens, being a full section of the large mass which we have been discussing. The etched surface of this slab was fully as striking as that shown in Plate I., but exhibited more uniformity in the distribution of the figures. Unfortunately, the slab was too large to allow of its reproduction on paper within the limits of this publication, but the figures can be best described by their resemblance to the markings of frost on a large window-pane. Around the edge the crystals were so compact as to show no details, but these compact masses joined the inner portion on a curved outline, looking like cloud masses which had floated in to the distance of from ten to one hundred millimeters from the crust, and on the inner edge of these cloudy portions the crystals became more distinct, and finally shot out in crystalline plates (which were seen of course only in section) some of them from fifty to one hundred millimeters in extent. These again were met and intersected by similar crystalline plates radiating from numerous centres through the mass, these centres being spots of more compact crystallization, like the cloudy masses around the edge, forming in the interior a network of plates producing skeleton crystals.

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* Proceedings of the American Academy, vol. xxiii., Plate I.

Thus the entire surface presented exactly the appearance that one might expect in a mass of iron which had slowly cooled. In such a mass, the surface cooling first would become compact, and exhibit only confused crystallization, while the interior, cooling more slowly, would allow time for isolated crystal plates to form; and at the same time local causes would start a simultaneous crystallization from other points in the interior, determined probably by the presence of nuclei of foreign matter.

The possible variation in the character of the figures brought out by etching different portions of the same iron, has been mentioned in a former paper,* but at that time no such striking example had been noticed as that now exhibited by the Coahuila irons. Specimens might be cut from the iron shown in Plate I. so selected that one piece when etched would give well marked Widmanstättian figures, with all the characteristic features which have commonly been associated with the so called typical octahedral irons, while another would show equally typical Neumann lines, and still a third piece would appear perfectly amorphous or made up of irregular grains.

WIDMANSTÄTTIAN FIGURES ON "SPIEGEL EISEN."

Hitherto Widmanstättian figures and Neumann lines have been considered the strongest characteristic of meteoric irons; but since it is merely the evidence of slow crystallization attended by the exclusion of foreign matter, one would expect that any impure iron, provided that it had cooled slowly from a state of fusion, would exhibit similar characters. From depending too much upon these features the Greenland iron was originally considered to be of meteoric origin, as some of the masses show very good Widmanstättian figures. Since specimens of cast iron have been frequently described as meteoric, and

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* Proceedings of the American Academy, vol. xxi. p. 478, May, 1886.

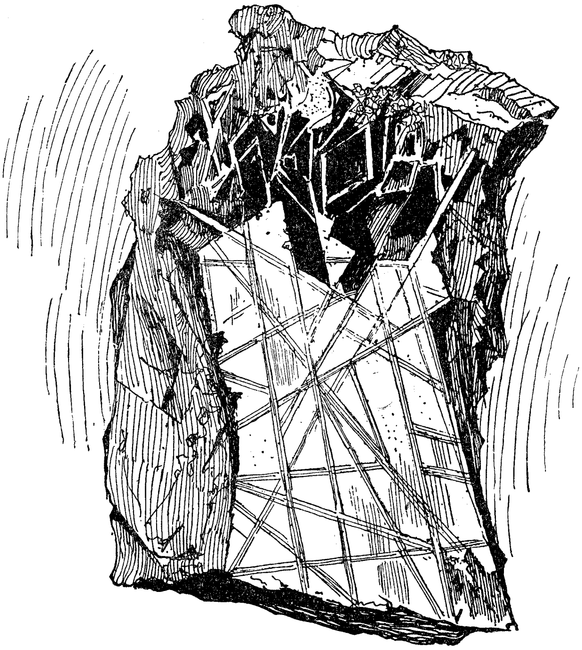

FIG. 1.

are to be found in all the large museums of the world, I was interested in examining specimens of " Spiegel Eisen," which contains so large an impurity of manganese, and is at the same time so strikingly crystalline. In the first place, the fracture somewhat resembles that of the Mexican irons which we have been discussing, as it shows cube faces, although the octahedron is dominant. Moreover, thin plates of "Spiegel Eisen" can in some cases be detached from the mass which would make it appear still more like meteoric iron, were it not for its great hardness. On a polished surface, however, the resemblance is far more striking, since etching or tempering brings out well defined Widmanstättian figures. These figures are shown of natural size in Figure 1, which is an exact sketch of the etched surface on a piece of this iron.

Crystalline Plates in Galena.

In this connection it may be of interest to describe some specimens of galena which appeared among the minerals used for blowpipe analysis by the class in mineralogy at Harvard College, but whose origin is unknown.

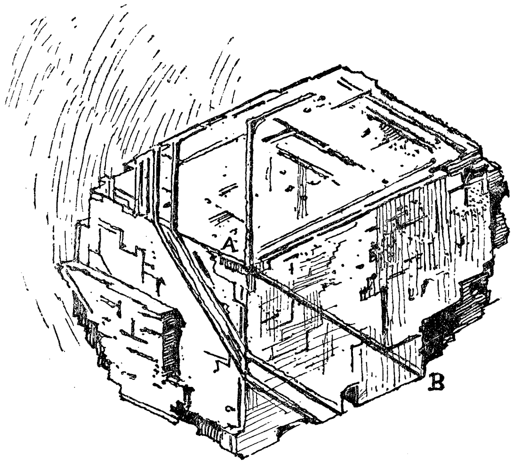

Fig. 2.

There were found three crystals very much alike, one of which is shown considerably enlarged in the accompanying sketch. On one side it showed the perfect cubic cleavage of ordinary galena, but the mass of the crystal consisted of a network of plates about 1 mm. thick, intersecting each other for the most part at right angles, and thus forming a skeleton cube. But that which makes the specimens of unusual interest is the fact that there are certain additional plates, following the direction of the faces of an octahedron, and thus running diagonally through the entire thickness of the crystals. Such a plate is shown at A B in the sketch (Fig. 2).

Moreover, the cleavage of the galena appeared to be due to some other cause than the form of the crystal, since the octahedral plates were as well marked and nearly as abundant as the cubic ones, while the cleavage was distinctly cubic. Thus it appears that when galena crystallizes, just as when iron crystallizes, plates form through the mass following the directions of both the cube and octahedron till the mass becomes solid, but that subsequently either cleavage may become so dominant as to wholly cover up all other crystalline structure.

CRYSTALLINE CONCRETIONS OF MICA.

Some time ago I received from Dr. D. F. Lincoln of Boston some remarkable specimens of curved mica, one of which is shown of natural size in Figure 3. This crystal had its cleavage face very much curved, while the successive layers tapered back to an apex at the centre of curvature, the whole having the appearance of forming a portion of a sphere. The occurrence of these micas is very well described in a letter from Dr. Lincoln : —

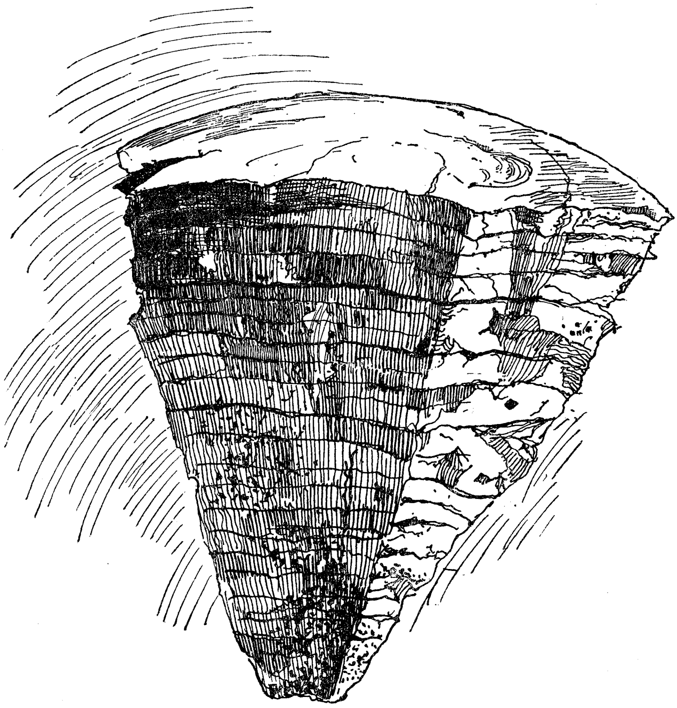

FIG. 3.

" The specimens of mica were procured by me in 1885, from Mt. Apatite in Auburn, Maine. The rock of that locality resembles that

of Mt. Mica, being a granite, with all its components (quartz, orthoclase, clevelandite, muscovite, black tourmaline, etc.), in very large masses. At the eastern end of the ridge there are several places where a very pure quartz is quarried in immense quantities. The peculiar mica is found at one of these quarries at points on the border of the quartz deposit. The coarser and less well formed specimens are imbedded in quartz and feldspar ; the finer and well formed are usually enclosed in feldspar alone. One vertical face of the quarry presented a most interesting exposure. Here the mica stood out in bosses, or huge breasts, looking like broken spheres developed from numerous centres, and grouped very irregularly. The spherical surfaces, on analysis, consisted of groups of rhombic figures, each representing a crystal of mica, with curved cleavage and tapering to the centre of the sphere."

Thus it appears as if these crystals were the result of two distinct tendencies acting together, one concretionary, exerted to make the mass solidify from centres, and the other the crystallizing force, tending to form at the same time the rhombic prism of 60° and 120° so characteristic of the mineral.